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Notice of Allowability	Application No.	Applicant(s)	
	09/931,412	YOSHIDA ET AL.	
	Examiner	Art Unit	
	George Nguyen	3723	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☒ This communication is responsive to *Applicant's amendment filed on February 16, 2005*.

2. ☒ The allowed claim(s) is/are *5-7,13,14,16 and 19-31*.

3. ☒ The drawings filed on *17 August 2001* are accepted by the Examiner.

4. ☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
   a) ☒ All b) ☐ Some* c) ☐ None of the:
      1. ☐ Certified copies of the priority documents have been received.
      2. ☒ Certified copies of the priority documents have been received in Application No. *09/423,445* .
      3. ☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

   * Certified copies not received: _____.

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.
THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.

5. ☐ A SUBSTITUTE OATH OR DECLARATION must be submitted. Note the attached EXAMINER'S AMENDMENT or NOTICE OF INFORMAL PATENT APPLICATION (PTO-152) which gives reason(s) why the oath or declaration is deficient.

6. ☐ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.
   (a) ☐ including changes required by the Notice of Draftsperson's Patent Drawing Review (PTO-948) attached
      1) ☐ hereto or 2) ☐ to Paper No./Mail Date _____.
   (b) ☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No./Mail Date _____.

   Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).

7. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Attachment(s)

1. ☒ Notice of References Cited (PTO-892)
2. ☐ Notice of Draftperson's Patent Drawing Review (PTO-948)
3. ☒ Information Disclosure Statements (PTO-1449 or PTO/SB/08), Paper No./Mail Date 050404
4. ☐ Examiner's Comment Regarding Requirement for Deposit of Biological Material
5. ☐ Notice of Informal Patent Application (PTO-152)
6. ☐ Interview Summary (PTO-413), Paper No./Mail Date _____.
7. ☐ Examiner's Amendment/Comment
8. ☒ Examiner's Statement of Reasons for Allowance
9. ☐ Other _____.

George Nguyen
Primary Examiner

REASONS FOR ALLOWANCE

1. The following is an examiner's statement of reasons for allowance: the specific limitations of "a handling table including ... with a predetermined position" in the combination as claimed in claim 5, "centering said polished and cleaned semiconductor wafer ... with a predetermined direction" in the combination as claimed in claim 13, and "a handling table including ... with a predetermined direction" in the combination as claimed in claim 16 are not anticipated nor made obvious by the prior art of record in the examiner's opinion. For example, Oishi et al.'5,655,954 discloses a polishing apparatus for polishing a semiconductor wafer comprising a processing section including a polishing section 8 and a cleaning section 12; a receiving cassette section 26; and a first robot 2 having a hand 28 as an end effector and a multi-joint arm which can move up and down corresponding to the height of a stack of wafers 11 in each cassette 16. The first robot 2 is provided with a pre-aligner for locating the delivered wafer 11 in the center of the hand 28 and aligning the wafer 11. To achieve this alignment according to the size of the wafer 11, a sensor attached to the first robot 2 can easily change a detecting position based on the wafer size.

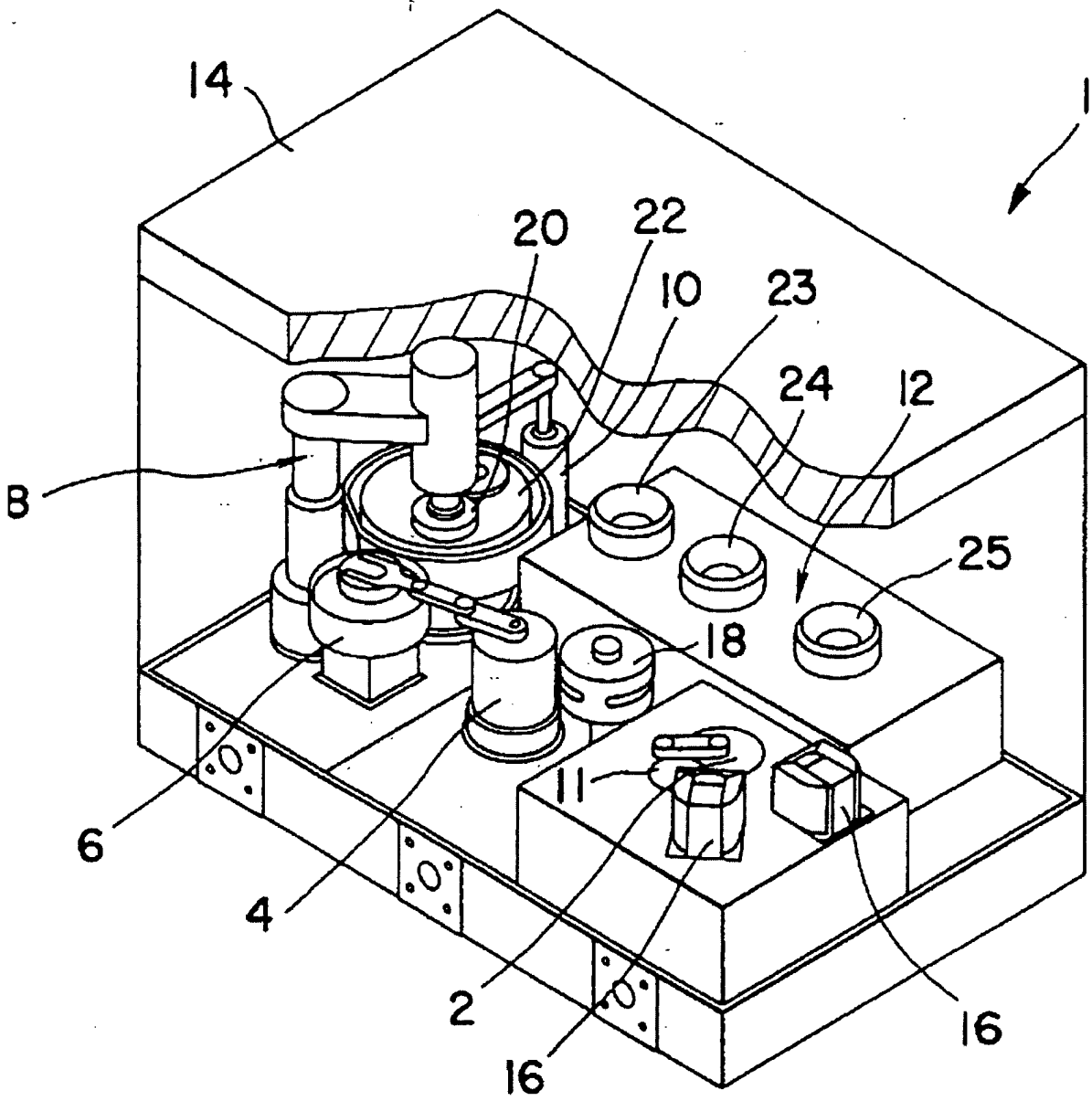

FIG. 1

attached to the partitioning means. Moreover, the respective internal pressures of the compartments can be individually controlled depending on the cleanness of each compartment so that the higher the cleanness, the higher the pressure. Even when the compartments communicate with one another, therefore, the air flow between each two adjacent compartments is directed from the compartment with a higher cleanness to the one with a lower cleanness. Accordingly, plenty of particles in a low-cleanness compartment cannot flow into a higher-cleanness compartment. Further, the diffusion of the particles can be restrained by producing air flows in the individual compartments.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic view showing a CMP apparatus according to a first embodiment of the present invention;

FIG. 2 is a plan view showing a layout of various devices of the CMP apparatus of FIG. 1;

FIG. 3 is a side view of the CMP apparatus;

FIG. 4 is a perspective view for illustrating the operation of a polisher;

FIG. 5 is a sectional view showing an arrangement of a loader device;

FIG. 6 is a schematic view showing a second robot and gutters arranged along the wafer transfer path of the loader device;

FIG. 7 is a cross-sectional view showing the principal part of a polishing apparatus according to a second embodiment of the invention; and

FIG. 8 is a profile showing part of a clean bench according to the second embodiment.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

A CMP apparatus according to a first embodiment of the present invention will now be described with reference to the accompanying drawings of FIGS. 1 to 6.

FIG. 1 shows an outline of the CMP apparatus 1 according to the present embodiment of the invention, and FIG. 2 is a plan view showing a layout of various devices which constitute the apparatus 1. The CMP apparatus 1 comprises a first robot 2 which constitutes wafer transportation means, second robot 4, loader device 6, polisher 8, dressing device 10, cleaning-drying device 12, etc. These devices are arranged individually in compartments which are defined in a clean bench 14. Each compartment of the clean bench 14 is adjusted to its optimum pressure by means of an exclusive-use clean unit. Each two adjacent compartments between which wafers are delivered are divided by means of a gate valve or air curtain.

The CMP apparatus 1 automatically performs a series of processes including polishing, cleaning, and drying of wafers 11. Unpolished wafers 11 are stored in a pair of cassettes 16. The wafers 11 are taken out from the cassettes 16 and temporarily placed on a provisional rest 18 by the first robot 2. The second robot 4 receives the wafers 11 from the rest 18 and sets them on the loader device 6 which is used as wafer attaching-detaching means.

robot 4. Arranged in a series in the cleaning-drying device 12 are a first cleaning section 23 for washing the reverse of the polished wafer 11 in pure water, a second cleaning section 24 for washing the obverse of the wafer 11 having being reversed, and a drying section 25 for drying the wafer 11 having being washed on both sides. The dried wafer 11 is restored to its home cassette 16 by the first robot 2.

The following is a detailed description of the respective arrangements of the individual devices.

Referring to FIGS. 2 and 3, the cassettes 16 and the first robot 2 are located in a cassette station 26. The first robot 2 has a hand 28 as an end effector and a multi-joint arm which can move up and down corresponding to the height of a stack of wafers 11 in each cassette 16, as shown in FIG. 3. The provisional rest 18 and the drying section 25 of the cleaning-drying device 12 are arranged within the working range of the first robot 2 so that the wafer 11 can be handled in a dry clean state in the cassette station 26.

The first robot 2 is provided with a pre-aligner (not shown) for locating the delivered wafer 11 in the center of the hand 28 and aligning the wafer 11. To achieve this alignment according to the size of the wafer 11, a sensor attached to the first robot 2 can easily change a detecting position based on the wafer size.

The second robot 4, loader device 6, polisher 8, and dressing device 10 are arranged in a polishing station 30. In this station, the wafer 11 is worked or handled in a wet state.

The loader device 6 and the first cleaning section 23 of the cleaning-drying device 12 are arranged within the working range of the second robot 4. The second robot 4 seizes the wafer 11 on the provisional rest 18 and sets it in the loader device 6. Also, it takes out the polished wafer 11 from the loader device 6, and delivers it to the first cleaning section 23 of the device 12. Like the first robot 2, the second robot 4 is provided with a liftable multi-joint arm, and in particular, a reversal mechanism 34 for rotating a hand 32 for 180° around a horizontal axis. Since the second robot 4 handles the wet wafers after the polishing work, all the sliding parts of the arm have a water- and drip-proof structure.

FIG. 4 shows an arrangement of the polisher 8. The polisher 8 comprises a column 36 set up in the vicinity of the base 22 and the loader device 6, a pivoted arm 38 mounted on the upper end portion of the column 36, and a rotating-lifting mechanism 40 attached to the distal end of the arm 38. The top ring 20 is attached to the lower end portion of the mechanism 40 by means of a rotating-lifting shaft 40*a*. The ring 20 is connected to the rotating-lifting mechanism 40 so as to be rotated and moved up and down by it. As the pivoted arm 38 swings, moreover, the ring 20 moves between the base 22 and the loader device 6. The wafer 11 is polished on the base 22. In the loader device 6, the wafer 11 is attached or detached, while the top ring 20 is washed.

As shown in FIG. 5, a vacuum chamber 20*a* is defined in the top ring 20. The chamber 20*a* communicates alternatively with a vacuum source or working air source by means of a tube 42. A wafer attracting face 20*b* is formed on the underside of the top ring 20. The wafer 11 can be held on the attracting face 20*b* by the vacuum chuck method using a negative pressure produced in the vacuum chamber 20*a*.

With reference to Figure 2, Marohl et al.'5,860,640 discloses semiconductor wafer an alignment member 16 and a clamp ring 12. To align the substrate on the support member 14, a frustoconical substrate alignment member 16 extends about the perimeter of the substrate receiving surface of the support member to capture a substrate received in the chamber and center the substrate on the upper surface of the support member.

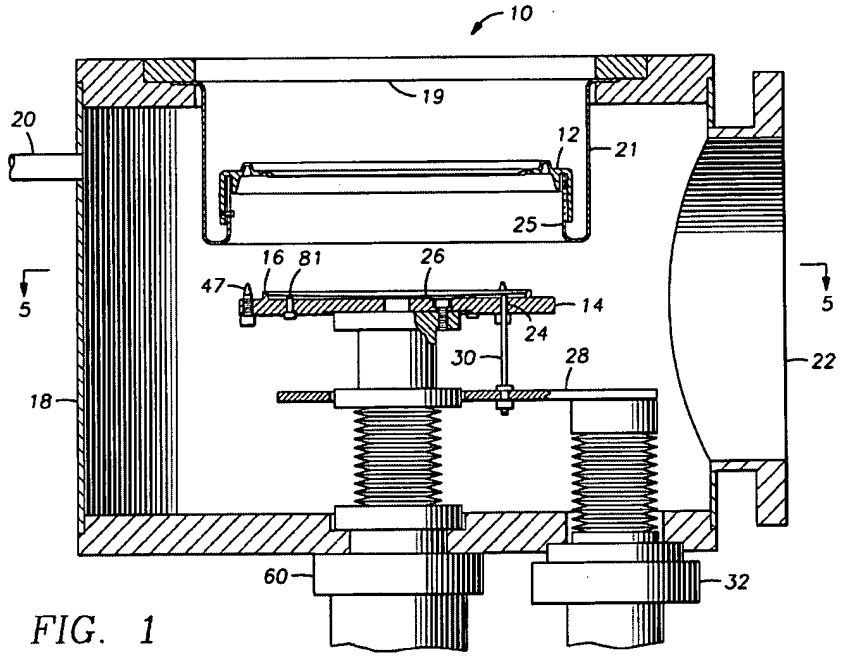

FIG. 1

member, having a base 27, a planar upper surface 28, an outer cylindrical surface 31 and an inner cylindrical surface 32. Uniquely, the inner cylindrical surface 32 includes a tapered alignment portion 34 extending radially inwardly from the upper surface 28. The alignment portion 34 intersects approximately midway between the base 27 and the upper surface 28 in a circular alignment ridge 36. The alignment ridge 36 creates a circular restriction sized to have a diameter slightly greater than the maximum diameter of the substrate 26, within acceptable substrate diameter tolerances. The alignment ridge 36 is positioned, with respect to the edge of the support member 14, to ensure that the edge of the substrate 26 is aligned with the edge of the substrate receiving surface 38 of the support member 14 to center the substrate 26 on the support member 14.

To enable centering of the substrate 26 on the support member 14, the alignment member 16 is positioned on the substrate support member 14 about the perimeter of the substrate receiving surface 38 of the support member 14. As the support member 14 is moved upwardly in the chamber and the substrate 26 is lowered on pins 30 into the alignment member 16, the substrate edge 24, if misaligned, contacts the alignment portion 34 of the alignment member 16. Because the alignment member 16 is fixed with respect to the support member 14, further movement of the pins 30 into the support member 14 will cause the substrate 26 to move radially inwardly, i.e., to a radially centered position, as it slides along the alignment portion 34 under gravity feed to become centered on the support member 14. The substrate 26, when misaligned, will continue to move radially inwardly as it is lowered onto the support member 14 until it passes the circular alignment ridge 36. Once the substrate 26 has moved below the alignment ridge 36, the substrate edge 24 is located adjacent to the inner cylindrical face 32 of the alignment member 16. Referring now to FIGS. 2 through 5, the cross-section of alignment portion 34 preferably has a beveled alignment portion 34 extending downwardly, and radially inwardly, from the upper surface 28 to the alignment ridge 36 to provide a frustoconical-shaped open mouth for receipt of a substrate. Thus, the frustoconical surface comprising the alignment portion 34 is inwardly tapered, i.e., it decreases in diameter as the distance from the upper surface 28 to a point on the alignment portion 34 increases.

In an alternative embodiment, the annular alignment member may include a wafer flat alignment surface 37 (shown in FIG. 5). The wafer flat alignment surface 37 aligns the flat portion of the wafer (used for wafer identification). in much the same manner as the annular substrate alignment member 16. The alignment portion 34 of the alignment member 16 having the wafer flat alignment surface 37 tapers inwardly and downwardly to a ridge formed between the upper surface 28 and the base 27. As a substrate having a wafer flat is received into the alignment member 16, the substrate rotates into alignment under gravity feed and slight vibratory movement resulting from the operation of the chamber until the wafer flat is aligned with the wafer flat portion of the alignment member.

Referring still to FIGS. 2 through 5, the alignment member 16 also provides alignment of the substrate 26 on the support member 14 without substantial risk that the substrate 26 will become adhered to the upper surface of the support member 14 while it is also in contact with the alignment member 16. The sequence of steps involved in aligning and securing the substrate in the processing position ensures that this does not occur, because the alignment member 16 properly aligns the substrate 26 before the support member 14 and the substrate 26 lift the clamp ring 12 off the hanger 21. As discussed above, the substrate 26 may be warped, or the pins 30 may not position the underside of the substrate 26 parallel to the substrate receiving surface 38 of the support member 14 as the substrate is being lowered onto the support member 14. Therefore, a portion of the substrate 26 may be closer to the support member than other portions of the substrate. The inner diameter of the alignment member 16, defined by the inner cylindrical wall 32, is sized slightly larger than the substrate 26 to ensure that the substrate is properly aligned on the support member 14. To provide this result, the proper height of the alignment ridge 36 is determined by calculating, from the warpage tolerance of the substrate, the alignment member spacing, the tolerance on the alignment ridge height and the positioning of the alignment member, the maximum possible distance differential between the point on the underside of the substrate 26 which will first contact the upper surface of the support member 14 and the point on the substrate farthest from that point measured along a path perpendicular to the support member surface, and sizing the height of the alignment ridge 36 greater than this distance.

If the substrate is dished, i.e., if it has a bowed convex or concave surface, the edge of the substrate 26 will move radially outwardly as the clamp ring 12 pushes the entire surface of the substrate 26 into contact with the upper surface of the support member 14. This may cause the edge of the substrate 26 to move radially outwardly as it is clamped. Typically, where the substrate 26 is dished, the substrate edge 24 will move through an arc, centered on the point of initial contact between the substrate and the support member 14, such that the closer the edge gets to the support member 14, the greater the radial extension of the edge. By providing the inner cylindrical wall 32 with a diameter slightly larger than the substrate 26, the substrate is centered on the substrate support member 14 by the inner cylindrical wall 32.

To provide the alignment features of the present invention, without substantially affecting the uniformity of the deposition or etch process, the alignment surface for aligning the substrate to the support member 14 may be provided on a plurality of indexing posts 40, preferably four to six, placed about the perimeter of the upper surface of the support member 14 as shown in FIGS. 9 and 10. Each of the posts 40 include an upper, inwardly tapered surface 42, a lower surface 44, and an alignment ridge 46 provided at the confluence of the upper and lower surfaces 42, 44. The posts 40 are placed about the perimeter of the support member 14, such that the center of the alignment ridges 46 are tangent to, and positioned on, a circle 50 centered about the center 52 of the circular support member. The circle 50 has a diameter slightly larger than the maximum, within tolerance, diameter of a substrate 26. The upper tapered surface preferably has the same taper, and relative size, as the alignment portion 34 of the alignment member 16. Likewise, the ridge 46 is preferably located the same distance from the upper surface of the support member as the alignment ridge 36 of the alignment member 16. Thus, the alignment posts 40 will center a substrate 26 on the support member 14 without significant contact between the substrate and the support member.

Although the alignment members have been described herein as being received on the support member 14, it is specifically contemplated that the alignment member 16 may be spaced from the support member 14, or may be positioned above the support member 14 on pins or other supports, such that the substrate is not surrounded by the alignment member 16 as it is received on the support

However, the prior art of record fails to provide or suggest the specific limitations of "a handling table including ... with a predetermined position" in the combination as claimed in claim 5, "centering said polished and cleaned semiconductor wafer ... with a predetermined direction" in the combination as claimed in claim 13, and "a handling table including ... with a predetermined direction" in the combination as claimed in claim 16.

Any comments considered necessary by applicant must be submitted no later than the payment of the issue fee and, to avoid processing delays, should preferably accompany the issue fee. Such submissions should be clearly labeled "Comments on Statement of Reasons for Allowance."

Any inquiry concerning this communication or earlier communications from the examiner should be directed to George Nguyen whose telephone number is 571-272-4491. The examiner can normally be reached on Monday-Friday/630AM-300PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Joseph Hail can be reached on 571-272-4485. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

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GN – April 12, 2005